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OPERATING AND SERVICING
MANUAL
FOR AC AMMETER CALIBRATOR
MODEL 250

Holt 250



Holt Instrument Laboratories

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DESIGNERS & MANUFACTURERS OF ELECTRONIC INSTRUMENTATION

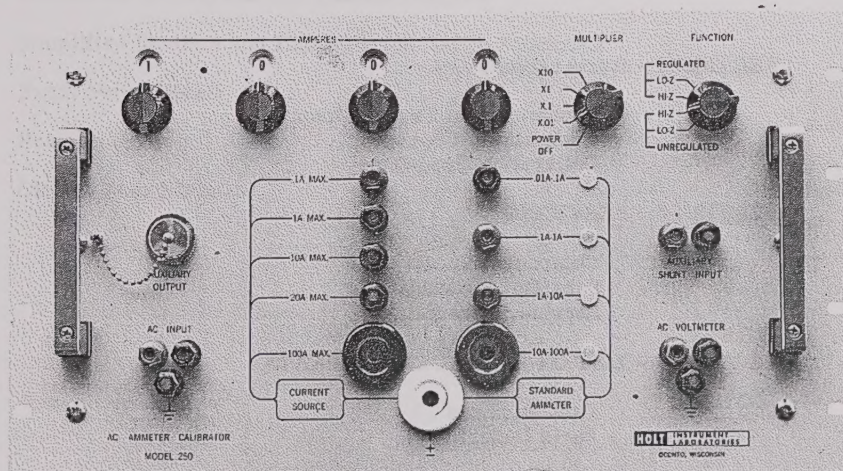


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OPERATING AND SERVICING
MANUAL
FOR AC AMMETER CALIBRATOR
MODEL 250

REVISED EDITION



THIS MANUAL TO ACCOMPANY
INSTRUMENT NO. - - - - -
APRIL 1969
HOLT INSTRUMENT LABORATORIES
OCOONTO, WISCONSIN

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NOTICE

When testing the Model 250 using a Holt Model 10 RMS Voltmeter, with a serial number prior to S/N 144, modification kit per field change order number 1019 should be added.

NOTE

This modification adds a switch to the Model 10 to improve its frequency response when using the Model 10 as a standardizing voltmeter with the Model 250. With this switch in the VOLTS or counterclockwise position, an error can be expected. With the switch in the MOD. 250 or clockwise position, the error is within the specified accuracy of the Model 10.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or it is damaged in any way, a claim should be filed with the carrier. Also, notify Holt Instrument Laboratories or the local representative immediately. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Holt Instrument Laboratories warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electron tubes, fuses, and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid, and when upon our examination it is to our satisfaction defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify either the factory or the area Holt representative, giving full details of the difficulty, and include the model and serial numbers. Upon receipt of this information we will give you service data or shipping instructions.
2. On the receipt of shipping instructions, forward the instrument prepaid to the factory or the authorized repair station indicated in the instructions. If requested, an estimate of the charges will be made before the work begins if such work is not covered by warranty. All shipments of Holt Instrument Laboratories' equipment should be packed in a strong exterior container surrounded by two or three inches of shock absorbing material.

APPENDIX

ACCESSORIES FOR MODEL 250 AMMETER CALIBRATOR

A set of accessories consists of the following items:

1. 100 Amp Cable Assembly, Holt #84541-1 *Blk*
2. 100 Amp Cable Assembly, Holt #84541-2 *Red*
3. 100 Amp Cable Assembly, Holt #84541-3 *white*
4. Pin Plug/5 Way Adapter, Holt #84538
5. Range Extender 500 Amps, Holt #90254

APPLICATION

These accessories make it possible to use the Model 250 to its full range of specified performance with a minimum of effort.

The three 100 amp cables, 84541-1, -2, and -3, are intended to plug directly into the three 100 amp terminals of the Model 250, J12, J13, and J14. They provide low resistance connection to ammeters or other loads under test. Each cable has a receptacle at the plug end which accepts a standard banana plug, allowing burden measurements as close as possible to the front panel terminals of the Model 250. The plugs are color coded for use with the intended panel jack.

The #84538 pin plug/5 way adapter is intended to be used when using the Model 250 measurement transformer capability when driving from an external current source. This adapter will plug into J14 when measuring currents below 10 amps. This allows connection to J6, J9, J11, and J14 with similar type connectors. As indicated in the Model 250 manual, J14 must always be used when driving from an external current source. At currents above 10 amps #84541-2 and #84541-3 will be used.

The 500 amp range extender #90254 is intended to be used for calibration of clamp-on ammeters in the range of 50 to 500 amps. The extender is a 5 turn coil. When used with the Model 250, this results in producing a 5 to 1 increase in ampere turns as measured by a clamp-on ammeter. Thus, the range of the Model 250 can be extended to 500 amperes at 50 to 65 Hz when calibrating clamp-on ammeters.

In use the extender plugs into J12 and J13. The clamp-on ammeter is inserted through the center of the adapter. Monitor the AC voltmeter terminals of the Model 250 as in the normal mode of operation. Multiply the dialed current by a factor of 5 to obtain the correct reading on the range extender. The specified accuracy is 0.5% of reading when the output voltmeter terminals are monitored to specified Model 250 accuracy.

SECTION 1

INTRODUCTION

1.1 General Description

a. The Holt Ammeter Calibrator Model 250, used in conjunction with an AC Voltage Source and an RMS Voltmeter, is an extremely accurate source of AC currents. It is an excellent current source for the calibration of ammeters over a wide range of current levels and frequencies.

b. The Model 250 can supply currents ranging from 10 milliamperes to 100 amperes. The current available at the output terminals is extremely stable with little distortion.

c. The Model 250 is capable of calibrating AC ammeters over a frequency range of 50 to 20,000 Hz at accuracies to 0.03%. The accuracy of the

standardizing voltmeter determines the overall accuracy to which the output currents may be established.

d. Although the Model 250 was designed primarily for the calibration of AC ammeters, its capability of supplying a wide range of currents over a broad spectrum of frequencies enables it to be used for many other applications. It can, for instance, calibrate many types of AC shunts, instrument current transformers, clamp-on ammeters, other current sources and, in conjunction with an accurate voltage source, wattmeters. In addition, the Model 250 can be used as a highly accurate AC current source or direct reading meter for many research laboratory measurements.

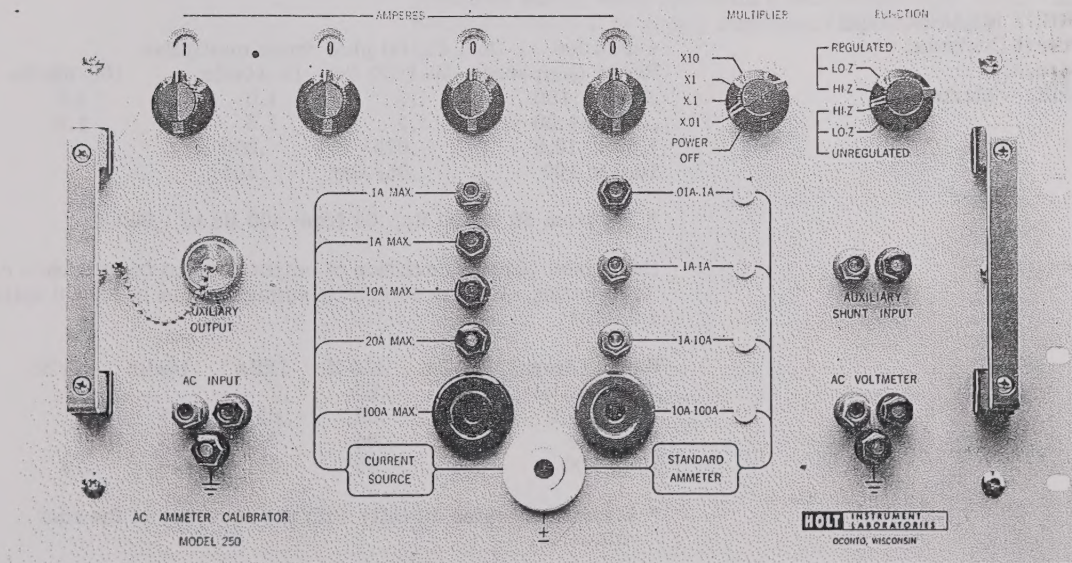


Figure 1. AC Ammeter Calibrator - Model 250

TECHNICAL SPECIFICATIONS

CURRENT GENERATION:

Driving Source Requirements:

10 VA Source:

200 ma capability from 1 VAC to 50 VAC.

10 VA capability from 50 VAC to 150 VAC.

20 VA Source:

200 ma capability from 1 VAC to 100 VAC.

20 VA capability from 100 VAC to 150 VAC.

30 VA Source:

200 ma capability from 1 VAC to 150 VAC.

Distortion:

Less than 0.1% added to that of the driving source.

Output-Input Characteristics:

(Output Isolated)

Current (Amp)	Max. Burden (Volts)	Frequency (Hz)	Max. Input Power (VA)
.01-.1	40.	50 to 1,000	15
.1-1	10.	50 to 20,000	15
1-10	1.5	50 to 10,000	20
1-10	1.25	10,000 to 20,000	20
1-10	2.5	50 to 10,000	30
1-10	2.25	10,000 to 20,000	30
10-20	.75	50 to 1,000	20
10-20	.60	1,000 to 10,000	20
10-20	1.25	50 to 1,000	30
10-20	1.10	1,000 to 10,000	30
20-100	.125	50 to 400	20
20-100	.075	400 to 1,000	20
20-100	.225	50 to 400	30
20-100	.175	400 to 1,000	30

CURRENT MEASUREMENT:

Preset Controls:

Burden:

(Volts - Maximum)

4 decades, in-line, digital plus range multiplier

Range (Amperes)	-50-1000 Hz	1k-10kHz	10k-20kHz
.010 to .100	1.0	1.0	1.0
.100 to 1.00	1.5	1.5	1.5
1.00 to 10.0	.075	.200	
10.0 to 100	.05/.08*	.500	

* .05 from 50 to 400 Hz, .08 from 400 Hz to 1,000 Hz.

Accuracy:

(Maximum percent deviation of output current from decade control setting when the reference voltage output is 1.0000 volts ± 0.02 .)*

Range (Amps)	50 Hz	400 Hz	1kHz	10kHz	20kHz
.010 to .100	.03	.03	.1		
.100 to 1.0	.05	.03	.03	.05	.1
1.0 to 10	.05	.04	.04	.05	.1
10 to 100	.05	.05	.05	.05	.15

* Accuracy derates directly with the accuracy of the rms voltmeter.

STANDARDIZING VOLTMETER

REQUIREMENTS:

Amplitude:	1 volt rms.
Impedance of Measuring Voltmeter:	144 to 200 ohms and high impedance.
Impedance Compensation:	The Model 250 provides rear panel terminals and controls which permit matching the Model 250 output circuit impedance to virtually any low impedance voltmeter. Adjustment of this circuit requires the application of an accurate 100 volts (100-1,000 Hz).
Accuracy:	For optimum accuracy the standardizing voltmeter should be rms responding and have an accuracy of 0.02%. If voltmeters of lesser accuracy are used or if average or peak responding voltmeters are used, the overall accuracy will be derated proportionately.

GENERAL:

Calibration Period:	1 year minimum.
Temperature Coefficient:	10 ppm/°C. maximum.
Ambient Operating Temp. Range:	+5 to +45° C.
Ambient Operating Relative Humidity Range:	10% to 90% R.H.
Power:	105-125/210-250 V, 50-60 Hz, 5 Watts.
Dimensions:	Bench Cabinet: 17" W x 10-1/2" H x 13" D. Rack Mounted: 19" W x 10-1/2" H x 13" D. Specifications subject to change without notice.

WEIGHT: Approximately 44 pounds.

ISOLATION: All output voltages are isolated from input ground

REGULATION: This ammeter calibrator is provided with an AUXILIARY OUTPUT connector and a FUNCTION switch with Regulated and Unregulated positions which, when used with a compatible Holt Audio Voltage Standard, allow it to supply regulated output currents.

SECTION 2

OPERATING INSTRUCTIONS

2.1 Preparation for Use

a. General. The Model 250 AC Ammeter Calibrator is supplied factory tested and calibrated. The unit is capable of operating on power lines of 105-125 or 210-250 VAC, 50-60 Hz.

b. Power Connections. The power cord is terminated in a three-prong male connector. Viewing the connector from the pin end with the round pin at the top, the left hand pin is connected to common, the right hand pin to the hot side of the lines, and the round pin to chassis. (See Figure 2.) It is important that the chassis be connected directly to a good earth ground connection. Large amounts of noise or 60 Hz voltage on the chassis may affect the performance. Be sure the power switch is in the OFF position before inserting the line plug. More than one ground should not be used with the instrument as circulating ground currents may cause errors in the readings.

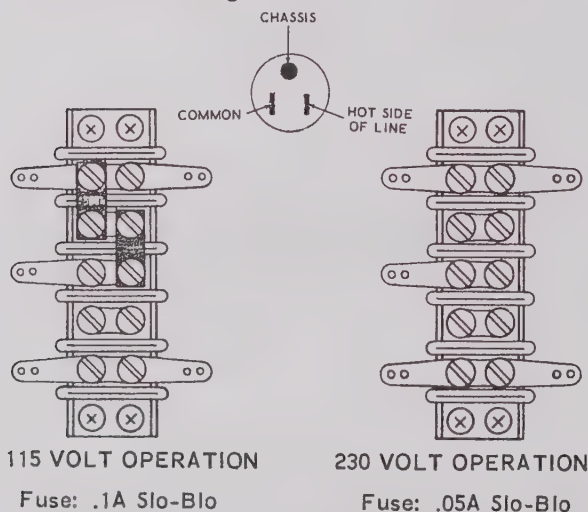


Figure 2. Power Supply Connections

c. Power Line Voltage. The instrument is designed for operation on power lines of 105-125 or 210-250 volts. Check the transformer connections and the line fuses to make certain that they correspond to those in Figure 2 for the particular line voltage to be used. The fuse is located on the rear panel of the instrument. The transformer connections are accessible by removing the top dust cover.

d. Operating Temperatures. The Model 250 is designed for operation over an ambient temperature range of +5 degrees to +45 degrees centigrade. There is little heat dissipated inside the instrument but the operator should be careful not to place the unit on top of a heat generating source which might raise its temperature above the maximum ambient specified.

2.2 Auxiliary Equipment

a. Equipment Required. The Model 250 is not a self-contained instrument. For proper operation, it requires an AC voltage source and a standardizing voltmeter for unregulated operation. To operate in the regulated mode, a compatible Holt Audio Voltage Standard such as the Models 630A, 631B, or the 325A can function as both the AC voltage source and the standardizing voltmeter to supply stable automatically regulated output currents. Operating technique for automatically regulated operation is contained in the instruction manuals of each of these above instruments. Also the Auxiliary Cables required for automatic current regulated operation of the Model 250 with each of these instruments are specified on the individual instrument specification sheets and are available as accessories to these instruments.

(1) Voltage Source. The accuracy of the AC voltage source is unimportant but it must have complete voltage variability from 1 VAC to 150 VAC and it should exhibit good short-term voltage stability. The waveform quality of the current supplied by the Model 250 to the ammeter under test is dependent upon the waveform quality of the voltage supplied by the voltage source. The Model 250 output current (current supplied to the ammeter under test) distortion will not be greater than the voltage source distortion plus 0.1%.

The burden capability (capability to supply rated current to an ammeter or other device under test which has a given input impedance) of the Model 250 is proportional to the power capability of the AC voltage source. For full rated operation, the AC voltage source must be capable of satisfying the 30 VA requirements set forth in the specifications over the frequency range of 50 Hz to 20 kHz. The Holt Audio Voltage Standards Models 323C and 325A fulfill these requirements and, in addition, the Model 325A can provide regulated current operation. Restricted operation with a reduced burden capability can be obtained in many ways. For example, the Holt Models 630A and 631B can be used as 20 VA sources over the frequency range of 50 Hz to 10 kHz and can provide regulated operation if desired. The Holt Model 613 can be used as a 10 VA source from 50 Hz to 5 kHz. Of course as the power capability of the source is reduced, the burden capability of the Model 250 is also reduced. In the extreme, a motor-generator set or a Variac connected to line voltage can be used as the AC voltage source when testing 3% panel ammeters, provided the distortion and short-term stability are adequate.

(2) Standardizing Voltmeter. The accuracy (accuracy of the STANDARD AMMETER section used to measure the current supplied to the am-

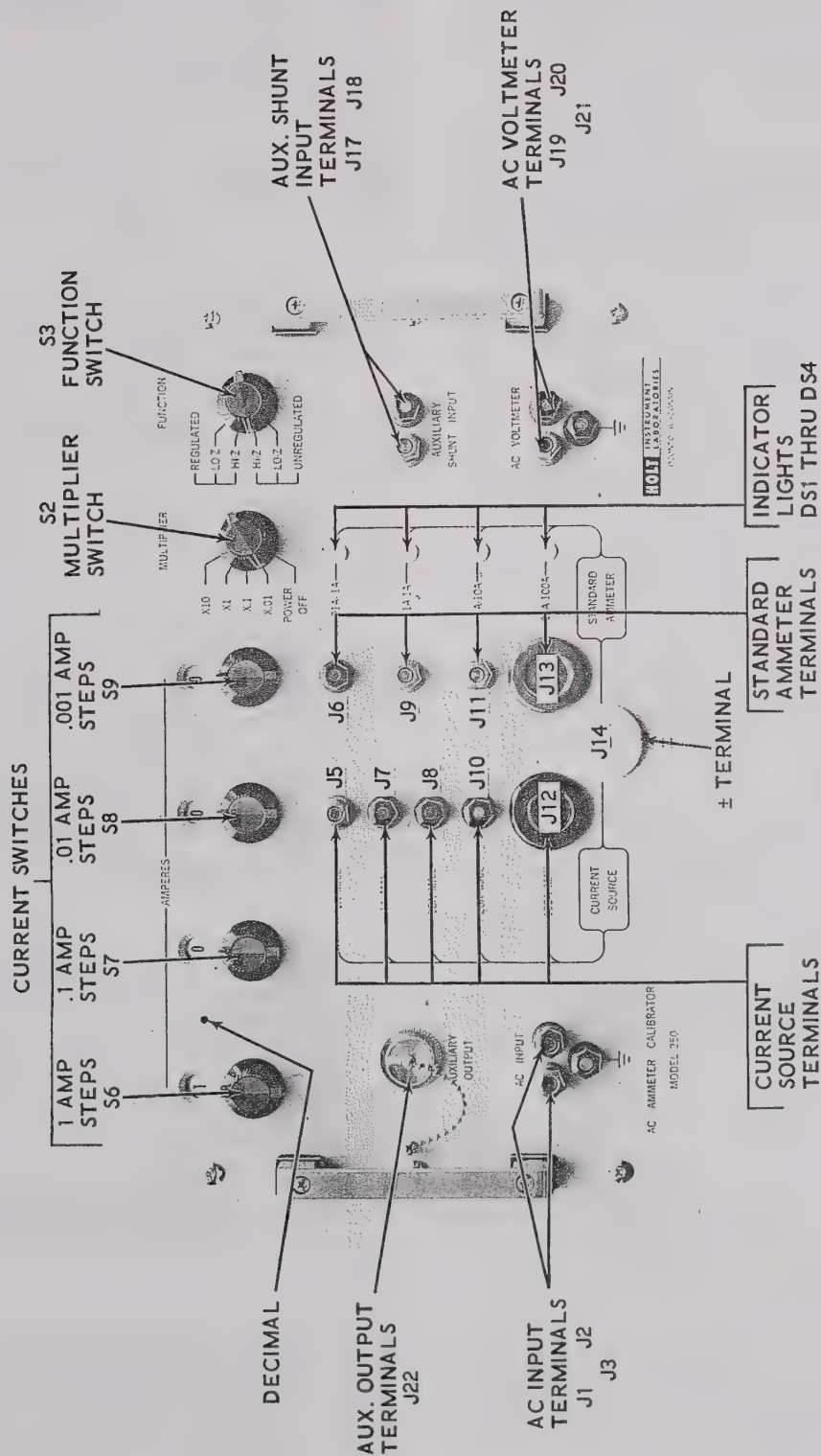


Figure 3. Operating Controls and Indicators - Front Panel

meter under test or to measure the current supplied by an external current source under calibration as described in section 2.7-d.) of the Model 250 is directly dependent upon the accuracy of the Standardizing Voltmeter. This voltmeter is required to measure 1 VAC over the frequency range in use.

To obtain the tight accuracies specified for the Model 250, a Thermal Voltmeter Standard such as the Holt Model 10 may be used, or a Thermal Transfer Voltmeter such as the Holt Models 6, 6A, or TV-1 in conjunction with a stable accurate 1 VDC source may be used. These voltmeters are rms responding with adequate NBS traceable accuracy. When using one of the above rms responding standardizing voltmeters, the AMPERES Decade Readout will indicate the true rms value of the current being measured within the stated accuracy of the Model 250. If an rms responding voltmeter of other design is used, the operator must determine that its protection circuitry (if it has such a circuit) does not cause erroneous readings when operated from an AC source with an output resistance of up to 400 ohms.

In general, rms responding Thermal Voltage Standards and Thermal Transfer Voltmeters exhibit an input resistance range of 144 to 200 ohms. The Model 250 contains a VOLTMETER INPUT IMPEDANCE CALIBRATION ADJUSTMENT circuit (procedure described in section 2.4) which compensates for this wide variation of input resistance exhibited by various rms responding voltmeters.

The Model 250 is also designed to accept a HI-Z (hi-impedance) standardizing voltmeter which may be rms or average responding. The new rms responding or average responding differential or digital voltmeters are ideal in this application. The Model 250 accuracy is degraded by the accuracy of the particular voltmeter used for standardization. The input impedance of such an electronic voltmeter should be in excess of 1 megohm to avoid loading errors (the output resistance of the Model 250 varies between 10 and 100 ohms depending upon the AMPERES DECADE switch settings).

2.3 Operating Controls and Indicators

The controls, indicator lights, and terminals located on the front and rear panels are described below and shown in Figures 3 and 4. These are the controls used in the normal operation of the Model 250. The internal controls and adjustments used in calibrating the instrument are covered in the appropriate maintenance section.

a. POWER OFF Switch. The POWER OFF switch is incorporated in the MULTIPLIER switch. When the MULTIPLIER switch is in the counterclockwise position, the power to the Model 250 is off. As the MULTIPLIER switch is turned clockwise to each succeeding position from this POWER OFF position, the instrument is energized and the proper indicator light, located directly below this switch,

lights to indicate the connection terminals to be used with that MULTIPLIER setting.

b. AMPERES Decade Switches. The AMPERES decade switches control the shunt resistors across which the output voltage of the Model 250 is developed. The left decade switch is the units decade and is variable in ten steps, 1 through 10. The next switch is the tenths decade variable in ten steps, 0 through 9. The third and fourth switches are the hundredths and thousandths decades respectively and both are variable in ten steps, 0 through 9.

c. MULTIPLIER Switch. The MULTIPLIER switch selects the appropriate connections between the STANDARD AMMETER current transformers and the decade ampere shunt. This switch also indicates the appropriate multiplier to be used with the AMPERES decade switches. As mentioned previously, this switch is also used as the power switch.

d. FUNCTION Switch. The FUNCTION switch has two purposes.

(1) It terminates the precision shunt section (section 3.3-b.) with 100 ohms for HI-Z operation using a standardizing voltmeter which has an input impedance in excess of 1 megohm. Or it terminates the precision shunt section with a variable resistance (VOLTMETER INPUT IMPEDANCE CALIBRATION ADJUSTMENTS) which, when paralleled by the LO-Z (low-impedance, 144 to 200 ohms) input impedance of a thermal voltmeter, can be adjusted to make the parallel combination of the voltmeter and the impedance adjustment controls exactly 100 ohms.

(2) When used with a compatible Holt Audio Voltage Source, it switches the voltage source from regulated output voltage operation (FUNCTION Switch in UNREGULATED position) to regulated current operation (FUNCTION Switch in REGULATED position). It is then the Model 250 output current which is automatically regulated. Regulated current operation is advantageous in making precision calibrations since current drift due to conductor heating and short-term current instability due to loose connections are nearly completely eliminated. Except when operated with a compatible Holt Audio Voltage Source, the FUNCTION Switch should always be in one of the two UNREGULATED positions.

e. CURRENT SOURCE and STANDARD AMMETER Terminals. These terminals provide connection to the current source and the standard ammeter sections of the Model 250. Their use varies with the application of the instrument. For Ammeter Calibration, see section 2.5, for Current Source Calibration see section 2.7-d. and for Use as a Current Source see section 2.7-e.

f. The STANDARD AMMETER Range Indicator Lights. Indicator lights are positioned on the right side of the panel adjacent to the STANDARD AMMETER input terminals to show the proper connection terminal for use with each position of the MULTIPLIER switch. These lights also indicate when power is applied to the Model 250.

g. AC INPUT Terminals. The AC INPUT terminals at the lower left of the instrument provide connection to the AC voltage source. A chassis ground terminal is also supplied.

h. AC VOLTMETER Terminals. The AC VOLTMETER terminals located on the lower right side of the panel provide connections for the standardizing voltmeter which is used to read the voltage drop across the AMPERE decade shunt.

i. AUXILIARY OUTPUT Connector. The AUXILIARY OUTPUT connector is located on the left side of the front panel. This connector is for the purpose of monitoring the AC VOLTMETER voltage to provide a feedback signal to a compatible Holt Audio Voltage Standard for automatic regulation of the Model 250 output current.

NOTE

The Models 325A, 630A, and 631B have been designed to utilize this feature.

j. AUXILIARY SHUNT INPUT Terminals. These terminals, located on the right, are used as the input terminals to the precision shunt section when calibrating an external current source in the 0.01 to 0.1 ampere range. See section 2.7-d.

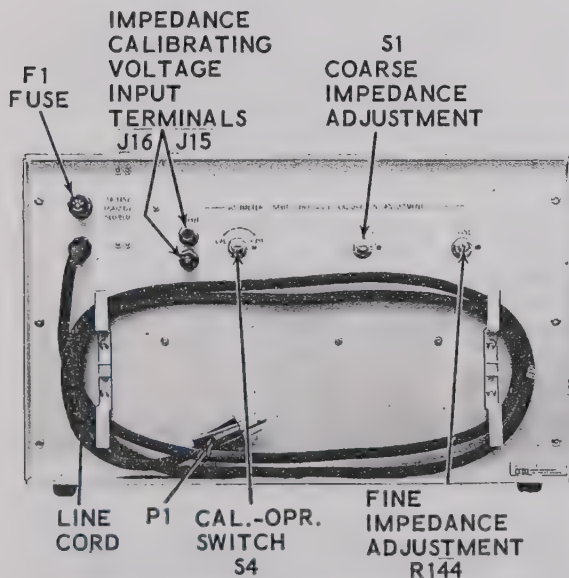


Figure 4. Operating Controls and Indicators - Rear Panel

k. VOLTMETER INPUT IMPEDANCE CALIBRATION Adjustments. These adjustment controls and terminals are located on the rear panel of the Model 250. The INPUT terminals on the left are for the application of an accurate 100 volts AC (100-1000 Hz) used for the calibration of this impedance. The CAL-OP switch, when in the CAL. position, makes the necessary internal connections. The COARSE control is a switch which compensates for variations in the input impedance of the voltmeter used with the Model 250. The FINE control is a potentiometer provided to allow precise adjustment of this voltmeter impedance.

2.4 Preliminary Adjustment

The following preliminary adjustment procedure describes the sequence for adjusting the Model 250 to match the input impedance on the Holt Model 10 voltmeter. The same general procedure, with minor modifications, applies to any other low impedance voltmeter. This input impedance calibration adjustment is necessary only when using a low impedance (144 to 200 ohms) standardizing voltmeter. This adjustment does not affect operation in the high impedance modes.

a. Set the FUNCTION switch, located on the front panel, to the UNREGULATED LO-Z position. Set the MULTIPLIER switch to OFF. Set the CALIBRATE switch on the rear of the instrument to the CAL. position. Connect the AC source to the AC INPUT terminals on the rear of the instrument. Apply a voltage of 100 volts AC at any frequency between 100 Hz and 1000 Hz. Connect the Model 10 to the AC VOLTMETER terminals on the front of the Model 250. Adjust the INPUT voltage source to exactly 100 volts rms (applied to the rear panel INPUT terminals). Adjust the COARSE and FINE IMPEDANCE CALIBRATION ADJUSTMENT controls on the rear panel of the instrument until the Model 10 reads exactly 1 volt. Recheck the voltage at the INPUT terminals to assure that it has remained within 0.02% of 100 volts. Note that the common terminal of the IMPEDANCE CALIBRATING VOLTAGE INPUT terminals is internally connected to the common terminal of the AC VOLTMETER terminals. Care must, therefore, be used to avoid ground loops when following the above procedure. This completes the input impedance calibration adjustments.

b. When using the Model 250 with a high impedance electronic voltmeter (instead of the Holt Model 10 or a thermal transfer standard), the FUNCTION switch on the front panel of the Model 250 should be set to the UNREGULATED HI-Z position. The setting of the VOLTMETER INPUT IMPEDANCE CALIBRATION ADJUSTMENTS does not affect operation in either of the HI-Z modes.

When exciting the IMPEDANCE CALIBRATING VOLTAGE INPUT terminals with one of the Holt compatible Audio Voltage Standards, the auxiliary cable described in section 2.2-a, must not be connected to the Audio Voltage Standard.

2.5 Operating Technique

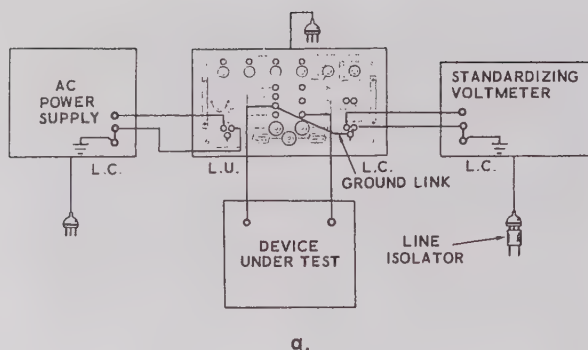
a. General. The operation of the Model 250 at currents from 10 ma to 10 amperes follows the general procedure described below. Certain special precautions are required at higher currents which will be covered in subsequent paragraphs.

b. Operation Above 100 Milliamperes. Connect the ammeter to be calibrated between the proper CURRENT SOURCE terminal and the proper STANDARD AMMETER terminal. For example, a 1 ampere ammeter would be connected between the 1A/MAX. terminal on the CURRENT SOURCE side and the 1A-1A terminal on the STANDARD AMMETER side. The junction connection between the STANDARD AMMETER and the CURRENT SOURCE is internal to the Model 250 and no additional connections are necessary to complete the circuit. If the ammeter to be calibrated has an internal ground, this grounded terminal should be connected to the black STANDARD AMMETER terminal. This is to insure maximum calibration accuracy. If the ammeter to be calibrated does not have an internal ground, connect a ground link between the black STANDARD AMMETER terminal being used and the ground terminal of the AC VOLT-METER connections on the Model 250 output. See Figure 5. Note the use of ground links and line isolators to interconnect commons but avoid ground loops. Set the MULTIPLIER switch to the X.1 position. Set the AMPERE decades to 10,000. Set the voltage source to 1 volt at the frequency at which the calibration is to be performed. Turn on the voltage source and gradually increase the voltage until the ammeter to be calibrated reads approximately 1 ampere and the standard voltmeter reads approximately 1 volt.

CAUTION

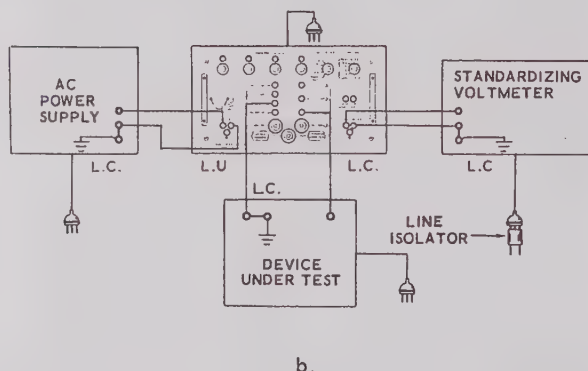
Do not raise the source voltage faster than steady state readings can be made on the ammeter and standard voltmeter. Over-current and over-voltage may damage these instruments.

Instrument Input-Output Burden specifications are based upon using the following source transformer taps (CURRENT SOURCE terminals) with the following STANDARD AMMETER ranges: 0.1 A. Max. with the .01A - .1A. range; 1A. Max. with the .1A. - 1A. range; 10A. Max. with the 1A. - 10A. range; 20A. Max. with the 10A. - 100A. range (10A. to 20A. specifications); and 100A. Max. with the 10A. - 100A. range (20A. to 100A. specifications). The use of other combinations is not recommended. Figures 5a and 5b show operation of the 10A. Max. with the 1A - 10A range. Operation with other above combinations requires movement of the leads from the device under test and the ground link lead to the appropriate Model 250 terminals.



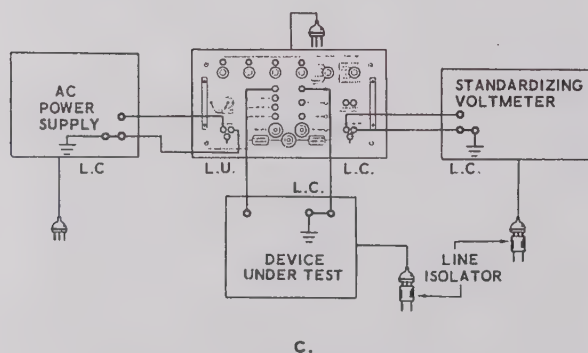
a.

CONNECTION FOR NON-GROUNDED AMMETER
(Operation above 100 Milliamperes)



b.

CONNECTION FOR GROUNDED AMMETER
(Operation above 100 Milliamperes)



c.

CONNECTION FOR OPERATION
BELOW 100 MILLIAMPERES

L.C. - Link Connected
L.U. - Link Unconnected

Figure 5. AC Ammeter Calibration

If the standard voltmeter indication rises to 1 volt considerably before the unknown ammeter reaches 1 ampere, there is a fault in the ammeter and it should be repaired before proceeding with the calibration. If the unknown ammeter and the standard voltmeter both read approximately the desired levels, proceed with the calibration as follows: Adjust the voltage source until the unknown ammeter is exactly on the scale point to be calibrated. Increase the null sensitivity of the standard voltmeter and adjust the AMPERE decade dials until a null is reached at 1 volt on the standard voltmeter. The true current in the unknown ammeter is now that which is indicated on the AMPERE decade dials times the MULTIPLIER switch setting of the Model 250.

c. Operation Below 100 Milliamperes. When operating below 100 milliamperes, the transformer in the STANDARD AMMETER is not utilized. Operating procedure is exactly the same as in paragraph 2.5.b. However, the block diagram of the connections for this operation is shown in Figure 5c. Note the difference in the ground connections.

WARNING

When using the .01A to .1A range, do not connect an external ground path between the black AC VOLT-METER terminal and the black current output terminal as is done on the other ranges. This connection is made internally and the wire resistance is critical. An additional current path in parallel will introduce error into the readings.

d. Operation Between 10 and 100 Amperes. When operating the Model 250 in the higher current mode (10 to 100 amperes), caution must be taken to remain within the rated burden on the instrument which corresponds to a source voltage of 150 V. It is important that short, heavy leads be used in the connection of the unknown ammeter. The procedure described in paragraph 2.5.b. applies here. However, if the operator finds that he cannot get the desired calibrating current with source voltages below 150 volts, he should check the voltage drop across the unknown ammeter and the drop across the leads connecting the ammeter to the Model 250, including connection resistances where the leads are connected to the Model 250 and to the unknown ammeter. If the sum of these voltages exceed the maximum burden specified in the current generation burden table of the specifications, the lead and contact resistances should be reduced by increasing the size of the lead and/or terminations.

When making ammeter calibrations of the highest accuracy, the stability of the current will depend largely on the stability of the ammeter circuit resistance. It is, therefore, important that con-

nections be tight and lead resistances as stable as possible. When the Model 250 is used with a compatible Holt Audio Voltage Standard, an adaptor cable may be used to provide current feedback between the Model 250 and the voltage source. This current feedback will stabilize the current level through automatic adjustment of the voltage source.

2.6 Precautions

Care must be taken to dress leads to the ammeter being calibrated to minimize inter-lead capacitances when using the 10 ma to 100 ma range. If the ammeter is highly inductive, the error resulting from this capacitance can be great. For example, a 40 volt inductive load with 10 pf capacitance in shunt with it can result in an error of 0.25% at 10 ma and 1 kHz. A 10 volt inductive load with 10 pf capacitance can result in an error of 1.2% at 10 ma and 20 kHz. Ammeters that are highly resistive show much less effect with this same capacitance. For example, a 40 volt resistive load at 10 ma with 10 pf capacitance in shunt can result in an error of 0.000% at 1 kHz and a 10 volt resistive load under the same conditions but at 20 kHz can result in 0.008% error.

2.7 Applications

a. General. The primary function of the Model 250 is to act as a secondary standard for the calibration of AC ammeters. Because of its inherent characteristics as an accurate, stable calibrator of AC currents, and because of its wide frequency range and high output current capacity, the Model 250 is usable in several calibration procedures. A few of the more common applications are detailed below.

b. AC Ammeter Calibration. The wide range of output currents permits the use of the Model 250 in the calibration of virtually every commercially available AC ammeter. Since the current is variable with high resolution, any and all full scale values may be checked as well as the linearity. The wide frequency spectrum available offers the possibility of calibrating for a specific frequency or checking over a broad frequency range.

c. Production Ammeter Calibration. Many companies have large quantities of meters that require accuracy checks at periodic intervals. The current capabilities of the Model 250 allow production testing of large numbers of instruments. This is accomplished by connecting several meters in series across the output terminals. There are limitations to this capability however. As explained in paragraph 2.5.d., care must be taken not to exceed the specified burden from the current range being used and the frequency at which the test is being made. Another limitation is with electronic ammeters. Those with internal grounds cannot be calibrated in series.

The best procedure is to set the Model 250 decade switches to a cardinal point plus the tolerance, turn up the voltage source slowly until the

(Shown connected for 1A-10A operation)

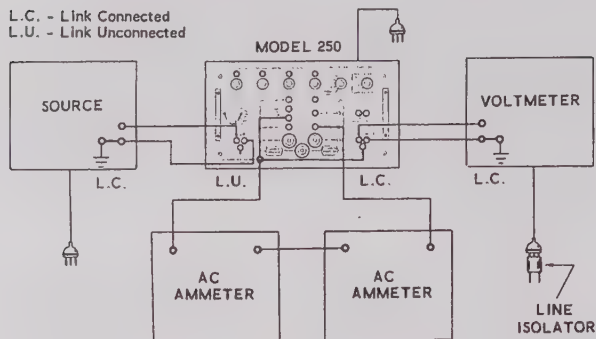
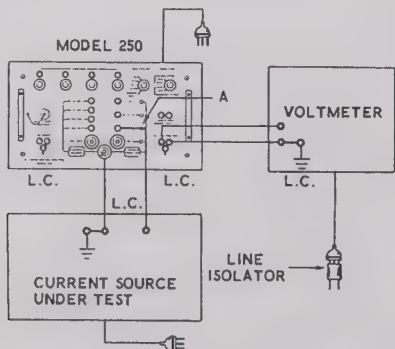


Figure 6. Production AC Ammeter Calibration

ammeters read nearly the desired current. Adjust the source to precisely 1V as indicated by the standardizing voltmeter; check all the meters under test to see that they read above the cardinal point; reject all those reading below. Reset the decade switches on the Model 250 to the cardinal point minus the tolerance; readjust the voltage source to again read 1 volt on the standardizing voltmeter; check all ammeters to see that they read below the cardinal point; reject all those reading above. Thus, the operator can select the instruments requiring calibration without the need to make any quantitative readings of the meters. See Figure 6.

d. Current Source Calibration. The Model 250 may also be used as a STANDARD AMMETER for the calibration of external AC current sources. Since the Model 250 is designed with a CURRENT SOURCE section and a STANDARD AMMETER section which are independent in operation and whose connections are accessible on the front panel, these sections can be used to generate uncalibrated currents as explained in section 2.7.e. or to measure externally generated currents as explained here.

To measure an externally generated AC current in the range of 0.1 to 100 amperes connection should be made to the Model 250 as shown in figure 7a and the MULTIPLIER switch should be in the appropriate current range position (connections shown for measurement of 1A. to 10A. currents. 0.1A. - 1A. and 10A. - 100A. range



(Operation above 100 Milliamperes)

Figure 7a. Current Source Calibration

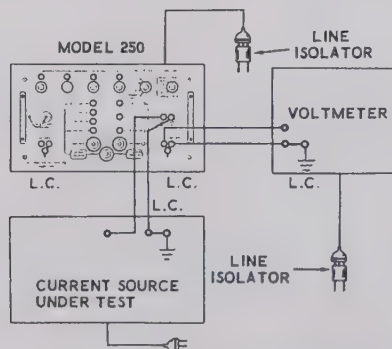
connections identical except for connection of LEAD A). Note that the white plus-minus terminal is used as the STANDARD AMMETER input common.

To measure an externally generated AC current in the range of 0.01 to 0.1 amperes, connection should be made to the Model 250 as shown in figure 7b. Note that the AUXILIARY SHUNT INPUT terminals are now used for the STANDARD AMMETER input connections. The black terminal is the input common. The MULTIPLIER switch should be in the X.01 position. Note the use of line isolators on the Model 250 and the standardizing voltmeter. These assure there will be no ground loop in the common connections and allow the current source being calibrated to pick up the earth connections.

The maximum burden of the Model 250 STANDARD AMMETER section upon the current source under calibration is given in the CURRENT MEASUREMENT-Burden section of the specifications. These are the maximum burdens on the indicated ranges at the specified frequencies and do not include lead resistance or inductance. At high currents it is important to use short, tightly connected leads and for low current-high frequency operation the lead-to-lead capacitance should be kept small (open leads) to avoid shunting current around the Model 250 STANDARD AMMETER section.

The FUNCTION switch should be in one of the UNREGULATED positions. If a LO-Z standardizing voltmeter (see section 2.2-2) is used, the switch should be in the UNREGULATED LO-Z position and if a HI-Z standardizing voltmeter is used the switch should be in the UNREGULATED HI-Z position. The use of a LO-Z voltmeter requires that the VOLTmeter INPUT IMPEDANCE CALIBRATION adjustments be made per section 2.4.

The accuracy requirements of the standardizing voltmeter are covered in section 2.2-2. When using an rms responding voltmeter, the external current source will be calibrated in terms of rms current. If the external current source exhibits a large amount of harmonic distortion, the use of an average or peak responding standardizing voltmeter will not provide accurate current calibration in terms of rms current.



(Operation below 100 Milliamperes)

Figure 7b. Current Source Calibration



DEPARTMENT OF THE ARMY
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REDSTONE ARSENAL, ALABAMA 35809

IN REPLY REFER TO
AMSMI-MF

MAY 9 1969

SUBJECT: Replacement Manuals, Dated April 1969, for Holt 250 Ammeter
Calibrator, Part Number 7912648

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1. Inclosed manuals are forwarded to replace the original manuals provided with the equipment. Due to a limited quantity of replacements, the distribution is as follows:

- a. Two per item at Transfer Level.
- b. One per item at Reference Level.

2. Request that all previous editions of the Holt 250 Manual be destroyed.

FOR THE COMMANDER:

1 Incl
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EDWARD R. HARRISON
MAJ, ORDC
C, Field Operations Div
US Army Metr & Calbr Cen

AMSMI-MF

SUBJECT: Replacement Manuals, Dated April 1969, for Holt 250 Ammeter
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CO, Tooele Army Depot, ATTN: AMXTE-QAC, Tooele, UT 84074
CO, 95th CS Calbr Co, ATTN: AMSMI-MC, Redstone Arsenal, AL 35809

CF:

CG, US Army Alaska, ATTN: ARAGL, APO Seattle 98749
CG, US Army Missile Command, ATTN: AMSMI-MFOP, Redstone Arsenal, AL 35809

Operation of the STANDARD AMMETER section of the Model 250 to measure external current sources is exactly the same as the techniques for this section set forth in section 2.5, i.e., current from external current source equals current shown on AMPERE DECADE dials of the Model 250 when standardizing voltmeter reads 1 VAC.

e. Use as a Current Source. The Holt Model 250, in conjunction with an AC voltage source, can be used as an uncalibrated AC current source which will operate from 0.1 amps to 100 amps. The use of the .01A to .1A range is not recom-

mended for current source purposes. When using the Model 250 as a current source, the load connects between the appropriate black CURRENT SOURCE terminal and the white plus-minus terminal. When the connection is made this way, an ammeter must be put in series with the load to measure the current since the Model 250 measurement circuit is not connected. Again the white plus-minus terminal should be used as the common connection. The burdens which the source transformer can drive will be approximately those given in the INPUT-OUTPUT Burden section of the specifications. The Driving Source Requirements of the voltage source remain unchanged.

SECTION 3

THEORY OF OPERATION

3.1 General Theory

The Holt AC Ammeter Calibrator - Model 250 is made up of two circuits: The source circuit and the measurement circuit. The source circuit transforms the high voltage, low current supplied by an external voltage source to high current, low voltage which is supplied to the output of the instrument. The measurement circuit senses the output current and, by means of decade shunt resistors and a standardizing voltmeter, displays the value of that current.

3.2 Auxiliary Equipment

The Model 250 is not a self-contained instrument. The CURRENT SOURCE circuit must be energized by an AC voltage source and the STANDARD AMMETER circuit must be monitored with a standardizing voltmeter. The required characteristics of these instruments are explained in section 2.2.

3.3 Basic Circuit Theory

a. The SOURCE Circuit. The current source consists of a single specially designed transformer T1. The primary of T1 is driven by the AC voltage source and its secondaries are designed to supply currents in the range of 10 milliamperes to 100 amperes. The design of each secondary winding and its connection to the front panel terminals has been optimized with respect to winding resistance, leakage inductance, and interwinding capacitance for this application. The transformer utilizes a high grade core which is operated at sufficiently low flux density so that the distortion introduced by T1 is well under 0.1% under all operating conditions. Primary-to-secondary isolation is obtained with interwinding shields.

The plus-minus terminal is common to each of the stacked windings (100 A. winding through the 1 A. winding). The 0.1A winding is isolated from each of the other secondaries and utilizes a driven shield arrangement.

b. The STANDARD AMMETER Circuit. The STANDARD AMMETER Circuit can be divided into the following sections: Measurement Transformers, Precision Shunt section, Compensating L-Pad, Meter Shunt, Standardizing Voltmeter, and the Voltmeter Input Impedance Calibration section.

(1) Measurement Transformers. Current measurements in the Model 250 are made in the 10 to 100 milliampere range. To measure larger currents, a special set of current transformers were designed to transform currents in the range of 0.1A to 100A down to the 10 to 100 milliampere range without an appreciable loss of accuracy. Transformer T2 has an approximate current ratio

of 10:1 to cover the measurement range of 0.1A - 1A. Transformer T3 has an approximate current ratio of 100:1 and 1000:1 (primary for 100:1 ratio is terminals 1 to 4 and primary for 1000:1 ratio is terminals 3 and 4) to cover the measurement ranges of 1A - 10A and 10A - 100A respectively. The secondaries of these transformers are switched via the MULTIPLIER switch either to common or to the precision shunt section. They are kept short circuited when not in use to avoid the possibility of damage. A simplified schematic is shown in figure 14.

(2) Precision Shunt Section. The precision shunt section consists of the AMPERE decade shunts (S6, S7, S8, and S9) and the meter shunt as shown in figure 8. The combination of these sections makes up a variable shunt unit of one mho per ampere with a 4-dial readout capability. Therefore, when the AMPERE decade switches are set to 1.000, 5.000 or 10.999 (picking values at random) there will be exactly 1 VAC across the meter shunt for input currents to the precision shunt section of 10.00, 50.00, or 109.99 milliamperes, respectively. Since 10 milliamperes also represents the lower current capability of the Model 250, current measurements from 10 to 100 milliamperes are made directly (without the use of a precision current transformer). A simplified schematic is shown in figure 13. To obtain the high accuracy of the Model 250, 4-terminal techniques are used to measure the voltage dropped across the meter shunt section. The high accuracy requirement also necessitates factory trimming of selective wire lengths within the precision shunt section. Since the 10 to 100 milliampere range is the only measurement range connecting the precision shunt section directly to the instrument under test, care must be taken to avoid unwanted ground current paths which would degrade the measurement accuracy (see section 2.5.c.).

(3) The Compensating L-Pad. Located between the Ampere Decade shunts and the Meter shunt is the Compensating L-Pad (R162 through R169). When a precision current transformer such as T2 or T3 is operated over a 10 to 1 range of input current its ratio error is not a constant. It is the function of the Compensating L-Pad to compensate for the ratio error changes in T2 and T3. The values used are a function of the individual

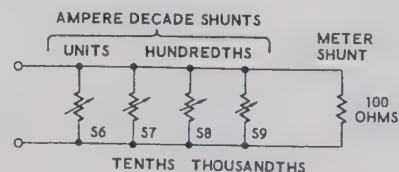


Figure 8. Simplified Precision Shunt Section

core characteristics of T2 and T3 which are nearly invariant with time. The MULTIPLIER switch selects the proper compensation for the transformer in use.

(4) Meter Shunt. Note that the precision shunt section is a variable one mho per ampere shunt. Note also that when S6, S7, S8, and S9 are in their fully ccw positions (corresponds to a readout indication of 1.000), the Ampere Decade shunts are open circuited. Therefore, there must be exactly 100 ohms across the AC VOLTMETER terminals in order to produce exactly 1 VAC for a current of 10 milliamperes. This is the Meter shunt. The composition of this 100 ohms may vary depending upon the FUNCTION switch setting in the following manner:

(a) UNREGULATED, HI-Z. In this position there is a 100.251 ohm resistor (R140) in parallel with a 40K ohm resistor (R171) to make up the required 100 ohms. Therefore, there will be the required 1 VAC at the AC VOLTMETER terminals provided the voltmeter has an input resistance in excess of 1 megohm.

(b) UNREGULATED, LO-Z. In this position the standardizing voltmeter input resistance must be considered as a part of the required 100 ohms. Therefore, the voltmeter input resistance is paralleled by an adjustable resistance branch (R143 through R160) and the fixed 40K ohm resistor R171. If the voltmeter resistance is between 144 and 200 ohms, it is possible to adjust this resistor branch so that the parallel combination equals the required 100 ohms. This adjusting procedure is called the VOLTMETER INPUT IMPEDANCE CALIBRATION ADJUSTMENT.

(c) REGULATED, HI-Z. The regulated positions are used only when exciting the Model 250 with a compatible Holt Audio Voltage Standard such as the Models 325A, 630A, or the 631B. An auxiliary cable is required with these units for regulated operation. In this position the converter of the Audio Voltage Standard is disconnected from its attenuator via S3B-R and the voltage developed across the Model 250 precision shunt section is substituted. By this method the output current of the Model 250 is automatically regulated. The 40K ohm resistor R171 is switched out in this position to compensate for the 40K ohm input resistance of the converter of the Audio Voltage Standards, full accuracy of the Model 250 can be

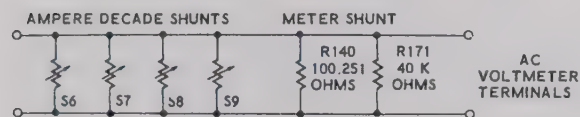


Figure 9. Precision Shunt Section for High Input Impedance Voltmeters

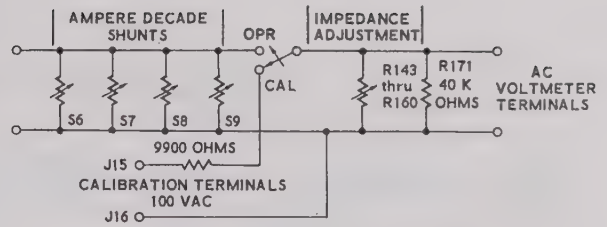


Figure 10. Voltmeter Input Impedance Calibration Section

achieved with regulated operation and a standardizing voltmeter is not required.

(d) REGULATED, LO-Z. This position exhibits the regulated characteristics of the REGULATED, HI-Z position and the LO-Z voltmeter capability of the UNREGULATED, LO-Z position.

(5) Standardizing Voltmeter. This piece of auxiliary equipment is adequately described in section 2.2.

(6) The VOLTMETER INPUT IMPEDANCE CALIBRATION ADJUSTMENTS. When operating in the LO-Z positions, the parallel combination of the standardizing voltmeter input resistance, the 40K ohm resistor R171 (or alternately the 40K ohm input resistance of the Audio Voltage Standard converter when in regulated operation), and the adjustable resistance branch R143 through R160 must equal the required 100 ohms. By exciting a series circuit composed of this parallel combination in series with a precision 9900 ohms, the required 100 ohms can be accurately obtained. An accurate 100 VAC is applied to this series circuit and when the standardizing voltmeter reads exactly 1 VAC, the parallel combination equals 100 ohms.

3.4 Power Circuit

The purpose of this circuit is simply to supply power to the indicator lights which indicate the STANDARD AMMETER terminal to be used for a given MULTIPLIER switch setting. Refer to figure 12.

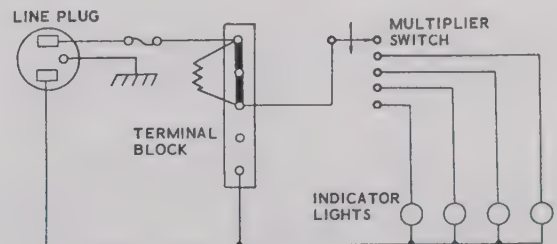


Figure 12. Power Circuit Diagram

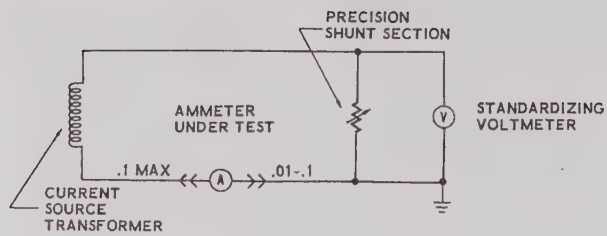


Figure 13. Simplified .01A-.1A Range Circuit Diagram

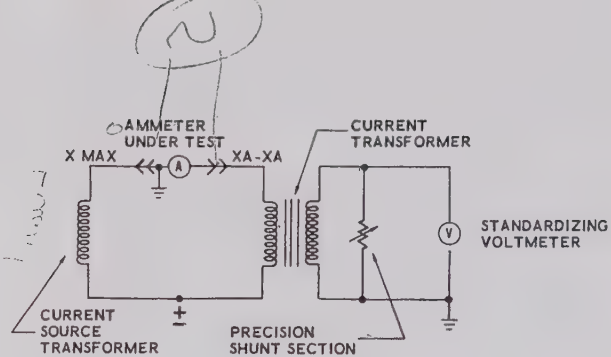


Figure 14. Simplified Medium and High Current Range Schematic

SECTION 4

RECALIBRATION

4.1 Recommended Test Equipment

When performing the maintenance and calibration checks as described in the following paragraphs, the recommended test instruments, or instruments of similar quality, should be used.

ITEM	MINIMUM USE SPECIFICATIONS	CALIBRATION EQUIPMENT
AC SOURCE	1-150 VAC, 50, 100, and 400 Hz. Stability .01%	Holt Model 323C, 630A, 631B, 325A
RESISTANCE BRIDGE (4-terminal)	.01%, 10 - 10,000 ohms	ESI Precision Resistance Measuring System - Model 242C
DIFFERENTIAL VOLTMETER	Calibrated	Fluke Model 883AB
AC AMMETERS	0-100 ma. 1/2% 0-1A. 1/2% 0-10A. 1/2%	

4.2 Preliminary Checks

a. Indicator Lights. Check the front panel indicator lights for operation and proper position for each setting of MULTIPLIER switch. If they are malfunctioning, check fuse, line cord, bulbs, and MULTIPLIER switch contacts.

b. Warm-up Period. Instruments stored or operated within the temperature range of +5 to +45 degrees C. need no warm-up.

c. System Grounding. The test instrument should carry the line ground alone. All other associated equipment should be operated off power line grounds by the insertion of 3 wire to 2 wire power cord adaptors (isolators) or with all ground posts (common) connected together, provide a single, heavy connection to ground from one point in the system.

d. Visual. Insure all controls, terminals, and indicators are free of damage or mechanical interference and all knobs and knob pointers are properly oriented and securely fastened to their respective shafts.

4.3 Calibration Procedure

This test procedure is sufficient to check the precise operation of the precision shunt section and the Voltmeter Input Impedance Calibration section. In addition, checks are made on the source transformer and the current measurement transformer. These checks are sufficient to assure that the operation characteristics of these transformers have remained unchanged. There should be no further tests necessary to assure proper operation of the Model 250.

In the event that this test procedure indicates that one of the above transformers has malfunctioned, we suggest that the instrument be returned to Holt Instrument Laboratories for repairs. A more thorough test procedure is available upon request

which also checks the precise operation of these transformers, but it requires the use of NBS traceable test equipment and should not be attempted by an facility except a Primary Standards Laboratory.

a. Source Transformer Checks. (AC Source, Differential Voltmeter). Connect the AC Source to the AC INPUT terminals. Set the instrument dials as below:

DIAL	SETTING
CAL-OPR	OPR
FUNCTION	UNREG., HI-Z
MULTIPLIER	OFF
DECADE READOUT	1.000

Set the AC Source to 100 VAC, 400 Hz. With the Differential Voltmeter measure the voltage present between the white plus-minus terminal and the below indicated CURRENT SOURCE terminals:

CURRENT SOURCE TERMINAL	VOLTAGE READING ± 5%
100 A. Max.	200 MV.
20 A. Max.	1 V.
10 A. Max.	2 V.
1 A. Max.	20 V.

Connect the differential voltmeter between the red 0.1A Max. CURRENT SOURCE terminal and the red AUXILIARY SHUNT INPUT terminal. The reading should be 40 VAC ± 5%. Disconnect all test equipment.

b. Meter Shunt Check. (Resistance Bridge). Make a 4-terminal connection of the Resistance Bridge to the Model 250 as follows: Bridge the current leads to Model 250 AUXILIARY INPUT terminals (black is common), bridge the voltage sensing leads to Model 250 AC VOLTMETER terminals (black is common). Set the Model 250 controls as follows:

<u>DIAL</u>	<u>SETTING</u>
CAL-OPR	OPR
FUNCTION	UNREG., HI-Z
MULTIPLIER	X.01
DECADE READOUT	1.000

The meter shunt resistance should be 100,000 ohms $\pm$ 0.01%. Leave the test equipment connected for the next test.

c. AMPERE DECADE Resistance Check. (Equipment connected per test b.). With the same control settings as in test b., check the resistance as the DECADE READOUT dials are in the below positions. Resistance should be the indicated value $\pm$ 0.01%.

DECADE READOUT SETTING	RES. (ohms)	DECADE READOUT SETTING	RES. (ohms)
1.100	90.909	2.000	50.0000
1.200	83.333	3.000	33.3333
1.400	71.429	4.000	25.0000
1.800	55.556	5.000	20.0000
1.900	52.6316	6.000	16.6667
1.010	99.010	7.000	14.2857
1.040	96.154	8.000	12.5000
1.090	91.743	9.000	11.1111
1.001	99.900	10.000	10.0000
1.004	99.602		
1.009	99.108		

c. Voltmeter Input Impedance Calibration Circuit Check. (Resistance Bridge). Make a 4-terminal connection of the resistance bridge to the Model 250 as follows: Hot voltage sensing lead securely fastened under J15, Common Voltage sensing lead securely fastened under J19, Hot current lead plugged into J15 via banana plug, Common current lead plugged into J19 via banana plug. Set the Model 250 controls as below:

<u>DIAL</u>	<u>SETTING</u>
CAL-OPR	CAL
FUNCTION	UNREG., HI-Z
MULTIPLIER	OFF
DECADE READOUT	1.000

The resistance should be 9900 ohms $\pm$ 0.01%.

d. Measurement Transformer Burden Checks. (AC Source, Differential Voltmeter). 0.1A - 1A Range - Securely connect a jumper beneath terminals J7 and J9. Place the voltmeter across the AC VOLTMETER terminals. Set the Model 250 controls as follows:

<u>DIAL</u>	<u>SETTING</u>
CAL-OPR	CAL
FUNCTION	UNREG., HI-Z
MULTIPLIER	X0.1
DECADE READOUT	10.000

Increase the AC source from 1 VAC, 400 Hz until the voltmeter reads 1 VAC. Disconnect the voltmeter from the AC VOLTMETER terminals and measure the voltage from J14 to J9 (plug into terminals with banana jacks). This voltage should be less than 0.75 volts $\pm$ 10%. 1A - 10A Range - Connect the voltmeter back across the AC VOLTMETER terminals and reduce the input voltage from the AC source. Move the jumper to short terminal J8 to terminal J11. Place the MULTIPLIER switch in the X1 position. Increase the AC source until the voltmeter reads 1 VAC. Move the voltmeter to read the voltage from J11 to J14. This should be less than 0.075 volts $\pm$ 10%. 10A - 100A Range - Connect the voltmeter back across the AC VOLTMETER terminals and reduce the input voltage from the AC source. Remove the jumper used in the above test. Plug in the 100A cable assemblies 84541-2 and -3 into J12 and J13 respectively. Securely connect their loose ends together with a bolt and nut. Place the MULTIPLIER switch in the X10 position and the AMPERES Decade Readout at 1.000. Increase the AC source at 50 Hz until the voltmeter reads 1 VAC. Move the voltmeter to read the voltage from J13 (use the special banana plug hole in the cable plug) to J14. This should be less than 0.006 volts $\pm$ 10%.

e. Measurement Transformer Accuracy Checks. (AC Source, Differential Voltmeter, AC Ammeters). It is unlikely that the core characteristics of the precision measurement transformers will ever change enough to affect the stated accuracy of the Model 250. This is, therefore, a test for a catastrophic failure which would result in a large change in the transformer current ratios. This is the reason for using 1/2% AC ammeters in this test.

(1) Construct the circuit shown in figure 5c (0.01A - 0.1A Range) with the 100 ma. ammeter as the device under test and the differential voltmeter as the standardizing voltmeter. Proceed through the calibration of this ammeter at the 100 ma. current level at 100 Hz.

(2) Reconnect the ammeter and adjust the Model 250 to calibrate the ammeter at 100 ma. on the 0.1A - 1A measurement range per figure 5a. The ammeter should have the same correction factor as when calibrated on the 0.01A - 0.1A range.

(3) Construct the circuit shown in figure 5a (0.1A - 1A range) with the 1A ammeter as the device under test. Proceed through the calibration of this ammeter at the 1A current level at 100 Hz.

(4) Reconnect the ammeter and adjust the Model 250 to calibrate the ammeter at 1A on the

1A - 10A measurement range. The ammeter should have the same correction factor as when calibrated on the 0.1A - 1A range.

(5) Calibrate the 10A ammeter at the 10A level at 100 Hz using the 1A - 10A measurement

range.

(6) Reconnect the ammeter and adjust the Model 250 to calibrate the ammeter at 10A on the 10A - 100A range. The ammeter should have the same correction factor as when calibrated on the 1A - 10A range.

SECTION 5

SERVICING

5.1 Components Locations

Components are labeled uniformly on schematics, parts lists, and illustrations. Location of a part can be determined by referring to the parts list. The number of the illustration showing the desired part is listed in the right hand column.

5.2 Servicing Precautions

There are some precautions that must be observed when servicing the Model 250. They must not be violated or permanent damage to the instrument may result.

a. Never substitute component types unless authorized by Holt Instrument Laboratories.

b. Never redress or remove a wire inside the instrument as the lengths and positions are factory selected for maximum accuracy.

5.3 Service Procedures

A standard procedure for servicing is recommended. Follow the sequence recommended be-

low to properly maintain the Model 250. In the event of a suspected malfunction of the equipment:

a. Check front panel controls and external power supply to insure that the malfunction is within the instrument.

b. Perform the preliminary checks as detailed in paragraph 4.2 to determine if recalibration is required or if a servicing problem is present.

c. If a service problem is indicated in the preliminary checks, the checking procedure should give an indication of where the trouble may be located.

d. Refer to the proper schematics, parts location illustration and the theory of operation for the section to be tested. These sections should give all required troubleshooting information.

e. In the event of difficulties in maintenance or calibration beyond the limitations of the servicing agency, contact Holt Instrument Laboratories for instructions.

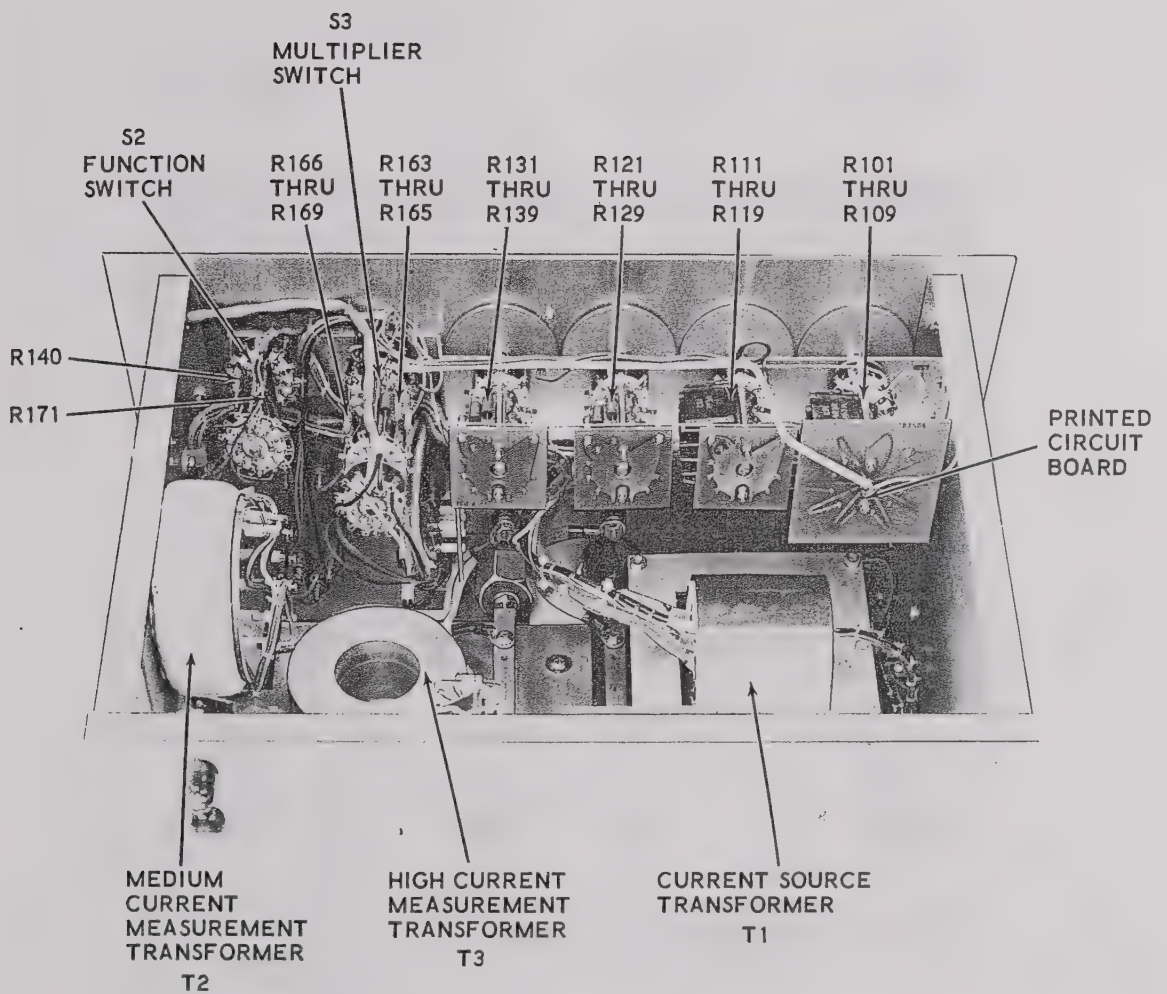


Figure 15. Front Panel Detail

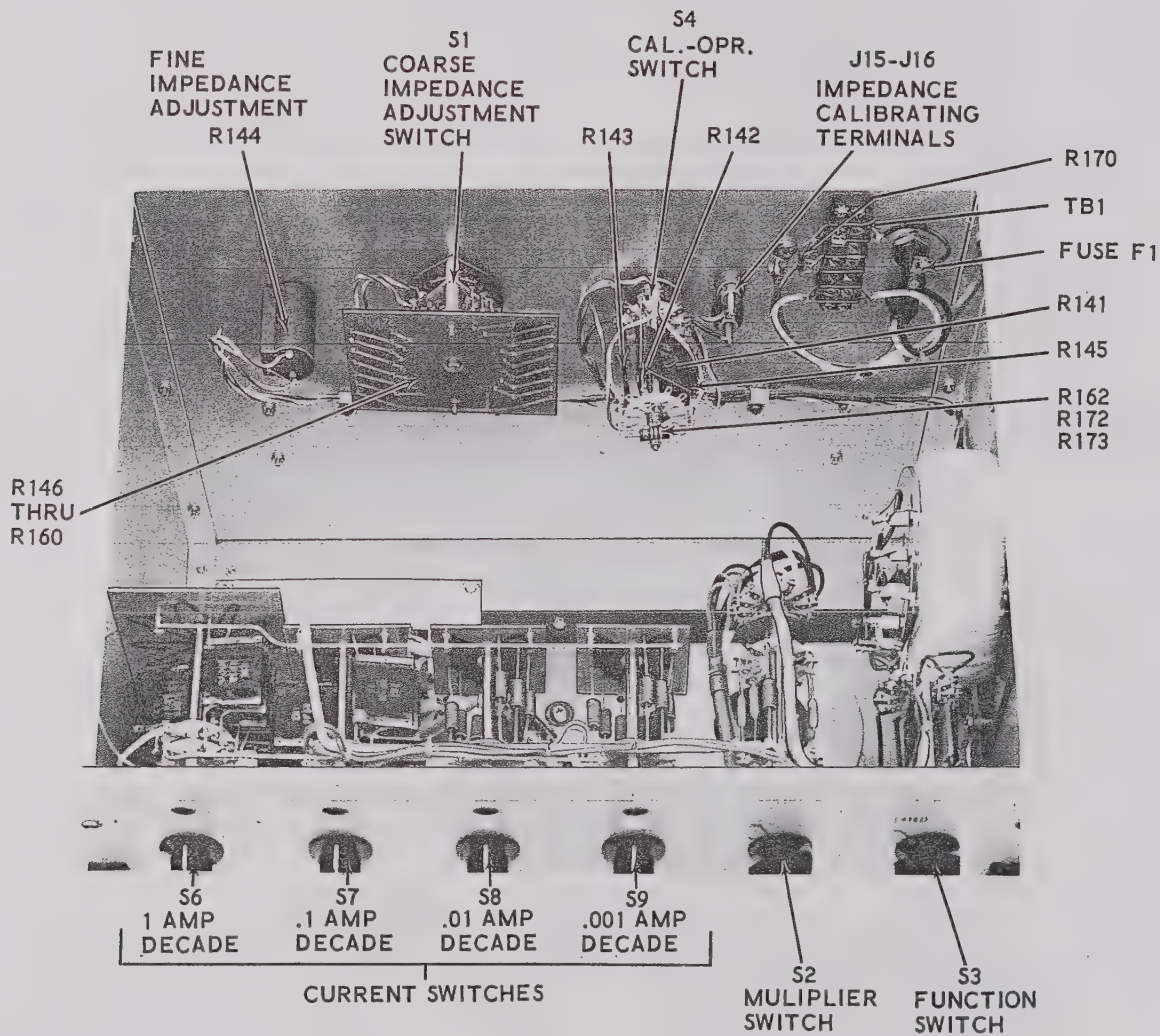


Figure 16. Rear Panel Detail

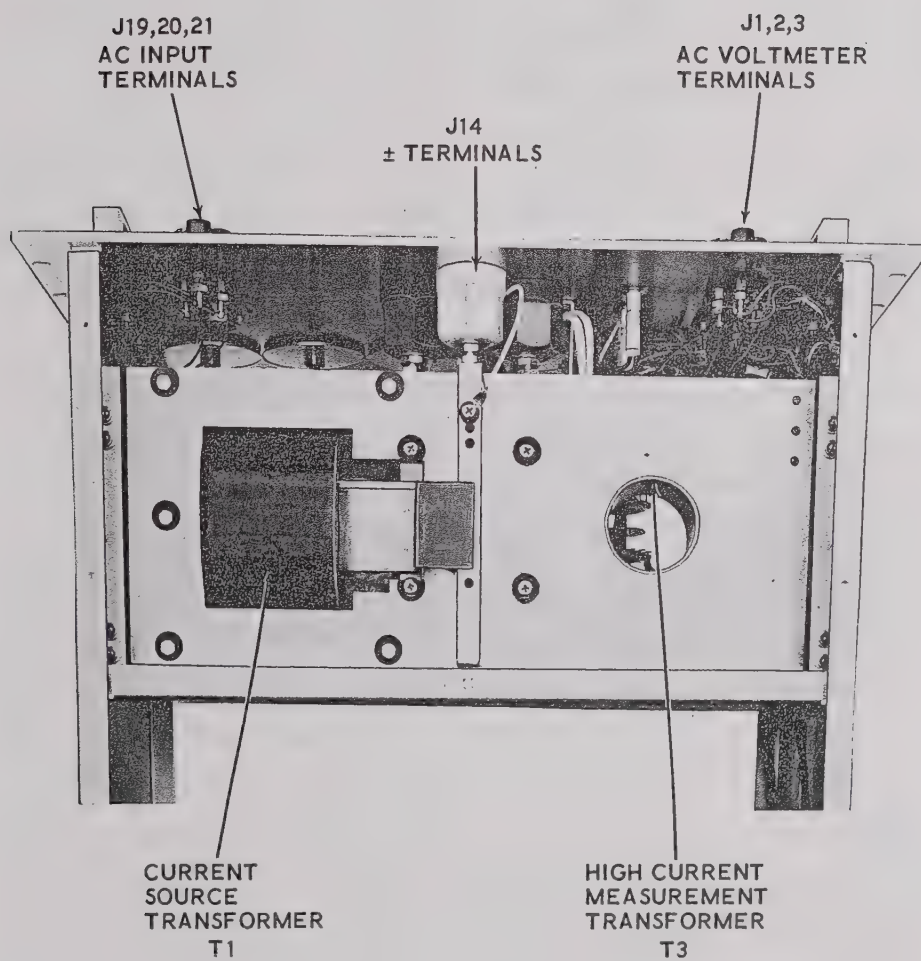


Figure 17. Circuit Board Detail

SECTION 6

LIST OF REPLACEABLE PARTS

6.1 Part Numbers

SUBASSEMBLIES

Holt Assembly Number	Description	Parts Included in Assembly
84508	1A/STEP DECADE	R101 thru R109
84475-1	.1A/STEP DECADE	R111 thru R119
84475-2	.01A/STEP DECADE	R121 thru R129
84475-3	.001A/STEP DECADE	R131 thru R139
84514	MULTIPLIER SWITCH ASSEMBLY	R162 thru R169
84512	FUNCTION SWITCH ASSEMBLY	R140, R143 thru R145 and R171
84476	COARSE SWITCH ASSEMBLY (REAR PANEL)	R146 thru R160
84515	CAL-OPR SWITCH ASSEMBLY (REAR PANEL)	R141 and R142

6.2 Parts Description

A complete description and the Holt Part Number is supplied for each replaceable part. When ordering parts, give the complete description, the Holt part number, the reference number, the model number, and the serial number of the instrument. Holt part numbers that begin with the number 5xxxx are manufactured or modified by Holt and must be purchased from Holt.

LIST OF REPLACEABLE PARTS

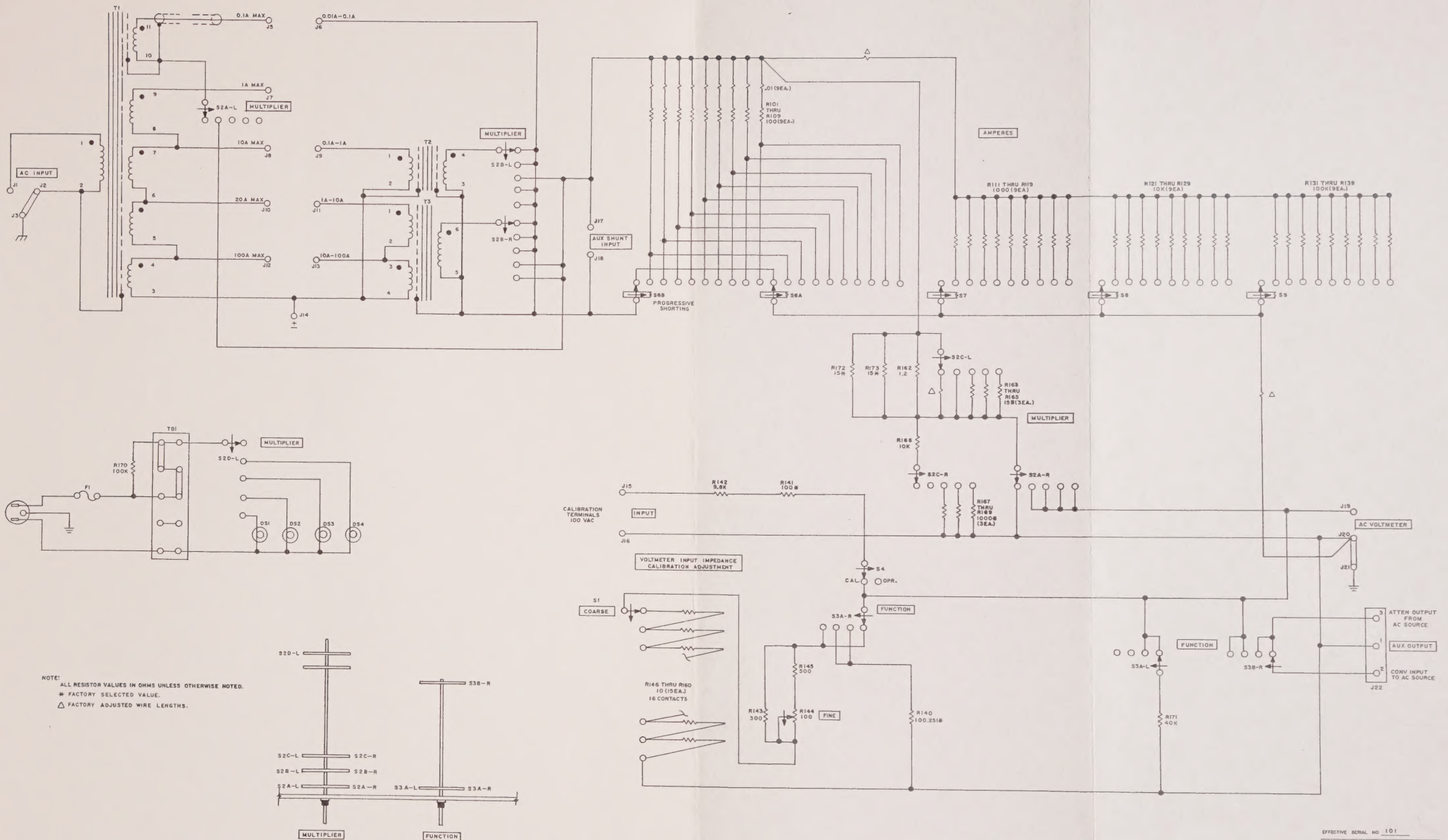
Circuit Symbol	Description	Holt Part No.	Manuf.	Catalog Number	Location Figure No.
DS1	Lamp - Assembly, Neon Red, 115 V.	0502-008	Industrial Devices	210041	3
DS2	Lamp - Assembly, Neon Red, 115 V.	0502-008	Industrial Devices	210041	3
DS3	Lamp - Assembly, Neon Red, 115 V.	0502-008	Industrial Devices	210041	3
DS4	Lamp - Assembly, Neon Red, 115 V.	0502-008	Industrial Devices	210041	3
F1	Fuse, Slo-Blo, .100 Amp, 250 Volts	1002-017	Buss	MDL	4
J1	Terminal Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	3
J2	Terminal Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J3	Terminal Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J5	Terminal Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	3
J6	Terminal Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J7	Terminal Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J8	Terminal Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J9	Terminal Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	3
J10	Terminal Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J11	Terminal Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	3
J12	Receptacle, Female, Black, 1 Pin	1701-086	Superior	RS-100GB	3
J13	Receptacle, Female, Red, 1 Pin	1701-087	Superior	RS100GR	3
J14	Receptacle, Female, White 1 Pin	1701-085	Superior	RS100GR	3
J15	Terminal, Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	4
J16	Terminal, Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	4
J17	Terminal, Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	3
J18	Terminal, Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J19	Terminal, Binding Post, 5 Way Red	1803-018	Superior	DF30RC12600	3
J20	Terminal, Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J21	Terminal, Binding Post, 5 Way Black	1803-017	Superior	DF30BC12600	3
J22	Receptacle, Female, 3 Pin	1701-006	Amphenol	91PC3F12601	3
P1	Line Cord, 3 Pin	1702-027	Cornish	3532-12612	4
R101	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15

LIST OF REPLACEABLE PARTS

Circuit Symbol	Description	Holt Part No.	Manuf.	Catalog Number	Location Figure No.
R102	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R103	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R104	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R105	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R106	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R107	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R108	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R109	Resistor, Wire Wound, $\pm .005\%$, 100 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-418	ESI	RF5R	15
R111	Resistor, Wire Wound, $\pm .01\%$, 1000 TC ± 3 PPM/ $^{\circ}$ C	0802-153	ESI	RF5R	15
R112 thru R119	Resistor, Wire Wound, $\pm .01\%$, 1000 TC ± 3 PPM/ $^{\circ}$ C	0802-153	ESI	RF5R	15
R121 thru R125	Resistor, Wire Wound, $\pm .05\%$, 100 K Ohms, .3 Watt	0802-230	RPC	LAC	15
R126 thru R129	Resistor, Wire Wound, $\pm .05\%$, 10 K Ohms, .3 Watt	0802-230	RPC	LAC	15
R131 thru R139	Resistor, Wire Wound, $\pm .1\%$, 100 K Ohms, .3 Watt	0802-420	RPC	LAC	15
R141	Resistor, Wire Wound, $\pm .01\%$, 100 Ohms, TC ± 5 PPM/ $^{\circ}$ C	0802-150	ESI	RF5R	16
R142	Resistor, Wire Wound, $\pm .005\%$, 9800 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-336	EXI	RF5R	16
R143	Resistor, Wire Wound, $\pm .005\%$, 300 Ohms, TC ± 2 PPM/ $^{\circ}$ C	0802-388	ESI	RF5R	16
R144	Resistor, Variable, 100 Ohms, 2 Watts	0802-083	Clarostat	62JA100	16
R145	Resistor, Wire Wound, $\pm .005\%$, 500 Ohms, TC 2 PPM/ $^{\circ}$ C	0802-387	ESI	RF5R	16
R146	Resistor, Wire Wound, $\pm .05\%$, 10 Ohms, .3 Watt	0802-421	RPC	LAC	16

LIST OF REPLACEABLE PARTS

Circuit Symbol	Description	Holt Part No.	Manuf.	Catalog Number	Location Figure No.
R147 thru R160	Resistor, Wire Wound, $\pm .05\%$, 10 Ohms, .3 Watt	0802-421	RPC	LAC	16
R162	Resistor, Wire Wound, $\pm 10\%$ 1.2 Ohms, 2 Watts	0802-242	IRC	BWH	16
R163 thru R165	Factory Selected		IRC	CEC-TO	15
R166	Resistor, Wire Wound, $\pm .05\%$, 10 K Ohms, .3 Watt	0802-230	RPC	LAC	15
R167 thru R169	Factory Selected		IRC	CEC-TO	15
R170	Resistor, Composition, 100 K Ohms, 1/2 Watt, 10%	0801-067	Al. Brad.	EB1041	16
R171	Resistor, Wire Wound, $\pm .005\%$ 40 K Ohms, TC ± 5 PPM/ $^{\circ}$ C	0802-359	ESI	RF5R	15
R172 and R173	Factory Selected		IRC	CEC-TO	16
S1	Switch, Rotary, 1 Deck, 16 Positions	1101-064	Ledex	312	4
S2	Switch, Rotary, 4 Deck, 5 Positions	1101-062	Ledex	312	3
S3	Switch, Rotary, 2 Deck, 4 Pole, 4 Positions	1101-067	Ledex	312	3
S4	Switch, Rotary, 1 Deck, 2 Positions	1101-063	Ledex	312	4
S6	Switch, Rotary, 2 Deck, 10 Positions	1101-065	Ledex	312	3
S7 thru S9	Switch, Rotary, 1 Deck, 10 Positions	1101-066	Ledex	312	3
T1	Transformer Source	54477	Holt		15
T2	Transformer, Low Current	54481	Holt		15
T3	Transformer, High Current	54482	Holt		15



EFFECTIVE SERIAL NO. 101

SCHEMATIC DIAGRAM
AC AMMETER
CALIBRATOR
MODEL 250
VOLT INSTRUMENT LABORATORIES
MOUNTAIN VIEW, CALIF.

MP MASTER



MA24255